ECOLOGICAL OBSERVATIONS ON THE FLORA OF THE SHALE BLUFFS IN THE VICINITY OF COLUMBUS, OHIO.

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The Ohio and Olentangy shales crop out in various places in this state, from the shores of Lake Erie in a line extending through the Scioto valley to the Ohio River. During the past summer and fall the writer has had an opportunity to study a few of these exposures, which are found north of Columbus along the Olentangy River and in the deep ravines leading into it from the east. The district studied embraced an area about ten miles in length by two in width and includes some of the best outcrops in the state.

The prevailing type of vegetation on the high dry land near the bluffs is the open white oak forest which contains also red and chestnut oaks, hickories, poplars and ashes. The undergrowth consists of straggling groups of papaw, Crataegus, black haw and blackberry. Further back beech forests, more or less mixed with other trees become quite frequent. Closer to the edge of the bluffs, in the dry usually well drained clay soil, the vegetation is decidedly xerophytic. This is readily seen from the list of herbaceous plants found here:

Agrostis hyemalis (Walt.)
Danthonia spicata (L.)
Poa compressa L.
Potentilla Canadensis L.
Linum Virginianum L.
Polygala verticillata L.
Euphorbia corollata L.
Hedeoma pulegioides (L.)
Pedicularis canadensis L.
Houstonia purpurea L.
Lobelia inflata L.
Hieracium venosum L.
Hieracium scarbum Michx.
Solidago ulmifolia Muhl.
Solidago nemoralis Ait.
Antennaria plantaginifolia (L.)
Gnaphalium obtusifolium (L.)
Achillea Millefolium L.

Such shrubby plants as *Rhus glabra, Rubus nigrobaccus* and *R. procumbens* with lichens and xerophytic mosses, are also always to be found here.

The slopes of the old ravines in which sufficient humus has collected, are clothed with a mesophytic growth of usually not very large trees, chiefly oaks, with a luxuriant shrubby and herbaceous undergrowth. In the more open ravines this herbaceous undergrowth is decidedly vernal, whereas in the narrower and deeper ravines, which are much more shady and moist, it consists mostly of ferns, and of these, *Dryopteris marginalis* is by far the most common. Here too, the beech takes the place of the oak, as it does at the base of the more open ravines.

The following are some of the commoner plants found in this mesophytic forest area:

Trees.

Juglans cinerea L.
Carpinus caroliniana Walt.
Ostrya Virginiana (Mill.)
Fagus Americana L.
Quercus rubra L.
Quercus velutina Lam.
Quercus coccinea Wang.
Quercus alba L.
Quercus acuminata (Michx.)
Amelanchier Canadensis (L.)
Prunus serotina Ehrh.
Aesculus glabra Willd.
Acer rubrum L.
Tilia Americana L.
Fraxinus Americana L.
Fraxinus quadrangulata Michx.
Cornus florida L.
Cornus alternifolia L. f.
Nyssa sylvatica Marsh.

Shrubs.

Ribes Cynosbati L.
Hamamelis Virginiana L.
Euonymus obovatus Nutt.
Staphylea trifoliata L.

Herbs.

Adiantum pedatum L.
Dryopteris marginalis (L.)
Dryopteris spinulosa (Retz.)
Filix fragilis (L.)
Filix bulbifera (L.)
Arisaema triphyllum (L.)
Carex albursina Sheldon
Carex Pennsylvanica Lam.
Unifolium Canadense (Desf.)
Salimonia biflora (Walt.)
Actaea alba (L.)
Hepatica acuta (Pursh).
Hepatica Hepatica (L.)
Syndesmon thalictroides (L.)
Thalictrum dioicum (L.)
Caulophyllum thalictroides (L.)
Sanguinaria Canadensis L.
Bicucula cucularia (L.)
Arabis laevigata (Muhl.)
Heuchera Americana L.
Aralia racemosa L.
Washingtonia Claytoni (Michx.)
Washingtonia longistylis (Torr.)
Mitella diphylla L.
Mitchella repens L.
Galium concinnum T. & G.
Nabalus altissimus (L.)
Solidago caesia L.
Solidago flexicaulis L.
Aster cordifolius L.
Polymnia Canadensis L.
Senecio obovatus Muhl.

It was interesting to watch the destruction of this mesophytic flora and the transition through the various stages of xerophytic life back to the mesophytic stage again. When a ravine has found its lowest level it begins to widen, a process which takes place very rapidly when a slight shifting of the current turns the streams against one of the soft shale banks for, as the shale is very brittle, a slight undermining causes it to break and slide. This strips the forest of its entire undergrowth; the

light humus going first, carrying with it the herbaceous plants, followed by the shrubs, leaving the larger trees with their securer holdfasts until last. The erosion may cease at this point, or it may go on until the slope becomes precipitous and is swept of its last vestige of vegetation.

In either case, the plants mentioned as being in the xerophytic zone above, may begin to creep down as soon as sufficient earth has been washed down to enable them to thrive.

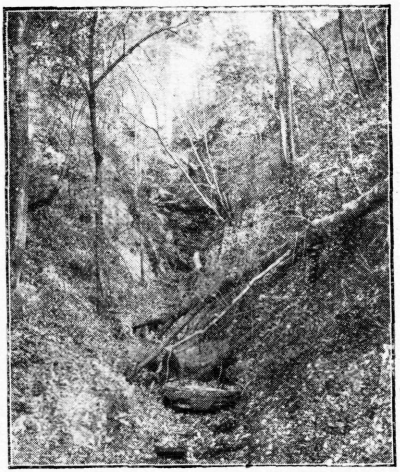

Fig. 1. View in upper end of a narrow ravine showing character of the vegetation.

Owing to the great isolation of the different ravines, there is less uniformity in the succession of the different plant societies than might otherwise be expected. Especially is this true of the earlier stages. Some of the first plants to appear on the pure exposed shale are the annuals *Anychia dichotoma*, *A. Canadensis* and *Oxalis stricta*. In some places nearer to civilization, *Melilotus alba* is one of the earliest occupants of the naked cliffs. In the shrubby thicket which follows, there is usually a great dearth in the number of species. *Rubus nigrobaccus* may be uniformly relied upon to appear first, while *Vaccinium vacillans*, *Gaylussacia resinosa*, *Amelanchier Canadensis* and *Acer rubum* are always found in the dryest, hottest and most exposed shales; and these, with a carpeting of lichens, mosses and Danthonia, may immediately be followed by a young sturdy growth of white and red oaks.

In ravines where the shale is kept moist by springs, or on the dry, southern and western exposures. *Solidago caesia*, *S. flexicaulis*, *Aster macrophyllus*, *Rubus occidentalis*, as well as *R. nigrobaccus*, *Hamamelis Virginiana*, with ferns, mesophytic mosses and liverworts obtain a foothold here, perhaps earlier than usual and are quite abundant.

An interesting plant society was found on a bluff at High Banks on the Olentangy River. This magnificent bluff is over one hundred feet in height, exposed to the rays of the afternoon sun, and in places so steep and the rock so loose that no vegetation has been able to gain a foothold. But few trees are found on this exposure; straggling and shrubby red and white oaks,

junipers, red maples, service-berries and hop hornbeams are the only representatives. The xerophytic thicket association, however, is well developed and consists of the following species:

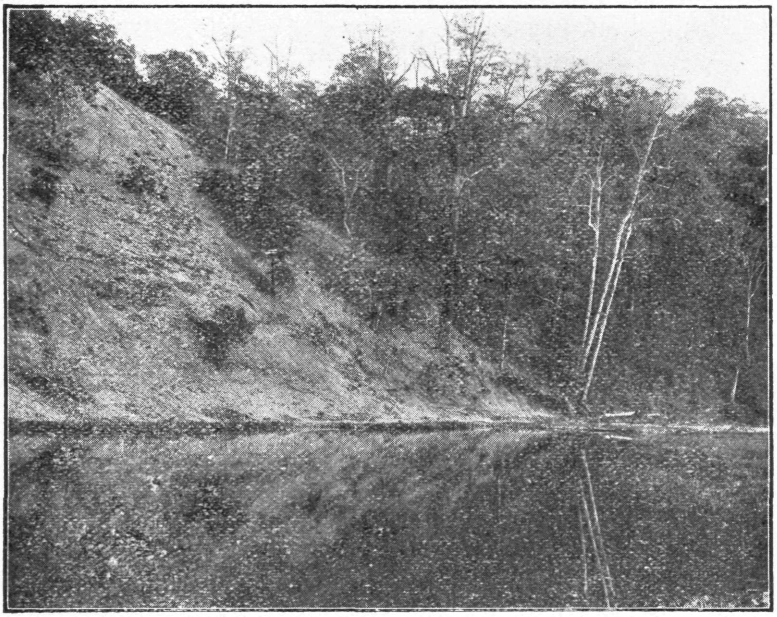

Fig. 2. A shale bank which has suffered from erosion. Here the vegetation has nearly all disappeared. A few trees still standing, indicate the type of the original forest.

Shrubs.

Rubus nigrobaccus Bailey.
Rubus procumbens Muhl.
Rosa humilis Marsh.
Aronia nigra (Willd.)
Rhus glabra L.
Rhus radicans L.
Euonymus atropurpureus Jacq.
Parthenocissus quinquefolia (L.)
Rhamnus lanceolata Pursh.
Vaccinium vacillans Kalm.
Gaylussacia resinosa (Ait.)
Polycodium stamineum (L.)
Diervilla Diervilla (L.)
Lonicera glaucescens Rydb.
Viburnum acerifolium L.
Viburnum prunifolium L.
Cornus candidissima Marsh.

Interspersed with and adjoining the above, were the following herbaceous perennials:

Andropogon scoparius Michx.
Andropogon furcatus Muhl.
Sorghastrum avenaceum (Michx.)
Muhlenbergia diffusa Willd.
Allium cernuum Roth.
Comandra umbellata (L.)
Euphorbia obtusata Pursh.
Taenidia integerrima (L.)
Aster laevis L.
Solidago ulmifolia Muhl.
Helianthus divaricatus L.

and the annuals:

Anychia dichotoma Michx. Oxalis stricta L.
Anychia Canadensis (L.)

The appearance of solitary specimens of such plants as *Hicoria microcarpa, Vitis vulpina, Carpinus Caroliniana* and *Fraxinus Americana* in this thicket, probably indicates a return to a mesophytic stage. This will never fully develop however, until the slope of the bluff has become such that sufficient humus can accumulate for the support of this type of vegetation.

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